

SUMMARY OF TOXICITY TESTING AND RELATED WATER QUALITY ANALYSIS OF PROPOSED EFFLUENT STREAMS AT THE CMS LAND COMPANY LTBEF

Addendum to the July 31, 2010 NPDES Permit Application

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Summary

The proposed discharges from CMS Land Company LTBEF based on acute and chronic testing of treated and/or comingled effluents are projected to meet MDNRE toxicity requirements of Rule 1219 ($<1 \text{ TU}_a$ and $<10 \text{ TU}_c$). The results of the various tests are summarized in Table 1 and the reports on the testing from the Great Lakes Environmental Center and Paragon Laboratories are enclosed.

Discussion

Outfall 002 (Development)

ECT UF Pilot Study

During the ECT UF pilot study, November 2009 – January 2010, acute toxicity testing was conducted on the effluent of two UF runs (Runs 1 and 3) of “all in” (Seep 1, Seep 2 with WCKD, Edge Drain, and TLC) influent mixtures. Acute toxicity tests were also conducted on UF effluent from a run (Run 6) of Seep 2 WCKD influent and from a run (Run 7) of Seep 2 WCKD, Edge Drain and TLC.

These tests were conducted following the procedures outlined by EPA-821-R-02-012, Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater Organisms, Fifth Edition and Great Lakes Environmental Center’s Standard Operating Procedures. Specifically, 48-hour toxicity tests were completed on *C. dubia* (*Ceriodaphnia dubia*) and 96-hour toxicity tests were completed on fathead minnows (*Pimephales promelas*). Dilute mineral water (DMW) was used as dilution water for the *C. dubia* tests, and moderately hard reconstituted water (MH) was used as dilution water for the fathead minnow tests.

The analyses included acute toxicity tests on four separate samples from the pilot test.

- BH Pilot R1 [Sample of Run 1 seep water (combined influent) collected at a concentration factor of 10X].
- R3 UF 0-10X [Sample of Run 3 seep water (combined influent) collected at a concentration factor of 10X].
- R6 [Sample of Run 6 seep water (Seep 2 only) collected at a concentration factor of 10X].
- R7 [Sample of Run 7 seep water (Seep 2, Edge Drain and TLC) collected at a concentration factor of 10X].

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Addendum to the July 31, 2010 NPDES Permit Application

The following are summaries of the results from each of the four toxicity tests:

Sample BH Pilot R1

The water sample was acutely toxic to both *C. dubia* and fathead minnows. The acute 48-hour *C. Dubia* LC₅₀ (Median Lethal Toxicant Concentration) estimate was 8.1 percent of sample, or 12.3 TU_a (acute toxic unit). The 96-hour fathead minnow LC₅₀ estimate was 25.0 percent sample, or 4.0 TU_a. See Table 1.

Sample R3 UF 0-10X

The water sample was acutely toxic to both *C. dubia* and fathead minnows. The acute 48-hour *C. Dubia* LC₅₀ estimate was 8.0 percent of sample, or 12.5 TU_a. The 96-hour fathead minnow LC₅₀ estimate was 17.5 percent sample, or 5.7 TU_a. See Table 1.

Sample R6

The water sample was acutely toxic to both *C. dubia* and fathead minnows. The acute 48-hour *C. Dubia* LC₅₀ estimate was 22.5 percent of sample, or 4.4 TU_a. The 96-hour fathead minnow LC₅₀ estimate was 42.0 percent sample, or 2.4 TU_a.

Sample R7

The water sample was acutely toxic to both *C. dubia* and fathead minnows. The acute 48-hour *C. Dubia* LC₅₀ estimate was 12.1 percent of sample, or 8.3 TU_a. The 96-hour fathead minnow LC₅₀ estimate was 16.7 percent sample, or 6.0 TU_a.

Based on the quality characteristics of the influent and effluent, the toxicity is attributed to the high levels of total dissolved solids (TDS) (4,000 – 7,740 mg/L) which is primarily comprised of potassium (2,500 mg/l).

No testing was conducted on *D. magna* and no chronic testing was conducted on any of the wastewater streams. The report from the Great Lakes Environmental Center on the four tests is attached.

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Addendum to the July 31, 2010 NPDES Permit Application

Captur Technology Pilot Study

Samples were collected of the effluent from the Captur Technology Pilot Treatment System, and of groundwater from the City of Petoskey's Well #3 on July 6, 2010. Acute and chronic toxicity studies were conducted by the Great Lakes Environmental Center on the Captur effluent, and on 4 to 1 and 5 to 1 mixtures of Well #3 water and Captur effluent. Testing was conducted on the groundwater/effluent mixtures to provide data representing CMS Land Company's proposed co-mingling (up to 6 to 1 mixture) of groundwater with treated leachate prior to discharge.

The following are summaries of the results from each of the toxicity tests:

Captur Effluent

The water sample was acutely toxic to *C. dubia*, *D. magna* and fathead minnows (FHM). The TU_a for *C. Dubia* was >16, for *D. magna* it was 8.5 and for FHM it was >16. The TU_c for *C. dubia* and FHM were 11.3 and >16, respectively. See Table 1.

Captur Effluent Co-mingled 1 to 4 with Well #3

The water sample was not acutely toxic to *C. dubia*, *D. magna* or FHM. The TU_c for *C. dubia* and FHM were 1.4 and 5.7, respectively. See Table 1.

Captur Effluent Co-mingled 1 to 5 with Well #3

The water sample was not acutely toxic to *C. dubia*, *D. magna* or FHM. The TU_c for *C. dubia* and FHM were 1.4 and 2.8, respectively. See Table 1.

Projected Whole Effluent Toxicity Levels of Outfall 002

CMS Land Company is proposing to co-mingle treated (UF or Captur) leachate from the Development with upgradient groundwater prior to discharge to Lake Michigan. The company has the capability of producing up to a 6 to 1 mixture of groundwater to treated effluent. Based upon the results of the testing of the Captur effluent co-mingled with upgradient groundwater at a 4 to 1 rate, the proposed discharge (with either UF or Captur treatment) will meet the acute and the chronic toxicity requirements of Rule 323.1219 Whole Effluent Toxicity. Although, UF effluent co-mingled with groundwater was not tested, nor was chronic testing conducted on UF effluent, CMS feels the results of the Captur co-mingled effluent tests can be extrapolated to UF co-mingled effluent. The extrapolation is reasonable since: 1) the UF effluent was found to be

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Addendum to the July 31, 2010 NPDES Permit Application

less acutely toxic than the Captur effluent, and 2) the toxic component of both the effluents, TDS, is at similar concentrations.

Outfall 001 (East Park)

UF Bench Scale Study

Following the Parson's UF Pilot Treatment Study in 2007, toxicity testing was conducted on effluent from a bench scale UF system. The bench scale system was operated by ECT and the effluent toxicity testing was conducted by Paragon Laboratories (report enclosed). The testing was conducted on leachate streams at both the Development and at East Park. Only the East Park results are discussed here since there are more recent and thus more representative testing results for the Development. The East Park sample was acutely toxic to *C. dubia*, *D. magna* and FHM. The TU_{50} s for the test organisms were: *C. Dubia* - 2.5, *D. magna* - 2.1, and FHM - 2.9. The TU_{10} s for the test organisms were: *C. Dubia* - 4.7, and FHM - 4.7 (See Table 1).

Although CMS is not proposing to treat the East Park leachate using UF, the bench scale UF toxicity testing is presented for comparison with the toxicity of the Development UF effluent. The East Park effluent was found to be less toxic (about 1/4 as toxic) presumably due to the lower concentration of TDS in the leachate and thus the effluent (1500 VS 7000 mg/L).

Projected Whole Effluent Toxicity Levels of Outfall 001

CMS Land Company is proposing to co-mingle treated (acid neutralization) leachate from the East Park site with upgradient groundwater prior to discharge to Lake Michigan. The company is proposing a 3 to 1 mixture of groundwater with leachate prior to discharge. There has been no WET testing of this proposed, however, it is projected that the discharge will meet the acute and the chronic toxicity requirements of Rule 323.1219 Whole Effluent Toxicity. The projection is based on the results of the bench scale toxicity testing, the toxicity testing that was done at the Development, and the calculated concentrations of the constituents that are expected in the proposed discharge. As indicated, it is believed that the toxicity of the leachate at the CMS Land Company LTBEF is due to the high concentration of TDS (primarily Potassium). The calculated concentrations of TDS (915 mg/L) and Potassium (126 mg/L) in the proposed East Park effluent are below levels that are considered toxic.

Table 1: Summary of water quality analysis and toxicity testing of proposed effluent streams at the CMS Land Company LTBEF

| Toxity test - species/type | UF Pilot Study Development Effluent (tox tests 11/09) (footnote 1) | Development Projected Effluent Quality (co-mingled up to 6 to 1 w/gw) - outfall 002 (footnote 3) | Captur Tech Pilot Study Development Effluent (tox tests 7/10) (footnote 4) | Development Well #3 (upgradient water used to co-mingle w/ treated effluent) | Captur Effluent co-mingled 4 to 1 with Well #3 (tox tests 7/10) | Captur Effluent co-mingled 5 to 1 with Well #3 (tox tests 7/10) | | UF Bench Scale Study East Park Effluent (tox tests 7/07) | East Park Projected Effluent Quality (co-mingled 3 to 1 w/gw) - outfall 001 (footnote 5) |
|--|--|--|--|--|---|---|--|--|--|
| C. dubia/acute/TUa | 12.5 (max of R1 and R3) | <1.0 | >16 | - | 0 | 0 | | 2.5 | <1.0 |
| D. magna/acute/TUa | - | <1.0 | 8.5 | - | 0 | 0 | | 2.1 | <1.0 |
| FHM/acute/TUa | 5.7 (max of R1 and R3) | <1.0 | >16 | - | 0 | 0 | | 2.9 | <1.0 |
| C. dubia/chronic/TUc | - | <10 | 11.3 | - | 1.4 | 1.4 | | 4.7 | <10 |
| FHM/chronic/TUc | - | <10 | >16 | - | 5.7 | 2.8 | | 4.7 | <10 |
| | | | | | | | | | |
| Chemical characteristic - Parameter/mg/L | (footnote 2) | | | | | | | | |
| Total Dissolved Solids | 6456.0 | 1963.0 | 4100.0 | 1000.0 | | | | 1500.0 | 915.0 |
| Potassium | 2500.0 | 300.0 | 1700.0 | 90.0 | | | | 500.0 | 126.0 |
| Mercury (ng/L) | 4.0 | <1.3 | 1.5 | <0.05 | | | | | <1.3 |
| | | | | | | | | | |

(1) - Maximum toxicity value from UF Runs 1 and 3 in which all 4 influent streams comprised an influent mix

(2) - Average concentrations from UF Runs 1 and 3 in which all 4 influent streams comprised an influent mix

(3) - Calculated projected effluent quality of outfall 002 (calculated based on upgradient well quality and UF water quality values - permit application)

(4) - Results of a Captur Technology Run in which all 4 influent streams comprised an influent mix

(5) - Calculated projected effluent quality of outfall 001 (calculated from upgradient well and frac tank water quality values - permit application)

Table 1: Summary of water quality analysis and toxicity testing of proposed effluent streams at the CMS Land Company LTBEF

| Toxity test - species/type | UF Pilot Study Development Effluent (tox tests 11/09) (footnote 1) | Development Projected Effluent Qulaity (co-mingled up to 6 to 1 w/gw) - outfall 002 (footnote 3) | Captur Tech Pilot Study Development Effluent (tox tests 7/10) (footnote 4) | Development Well #3 (upgradient water used to co-mingle w/ treated effluent) | Captur Effluent co-mingled 4 to 1 with Well #3 (tox tests 7/10) | Captur Effluent co-mingled 5 to 1 with Well #3 (tox tests 7/10) | | UF Bench Scale Study East Park Effluent (tox tests 7/07) | East Park Projected Effluent Quality (co-mingled 3 to 1 w/gw) - outfall 001 (footnote 5) |
|---|---|--|--|--|---|---|--|--|--|
| C. dubia/acute/TUa | 12.5 (max of R1 and R3) | <1.0 | >16 | - | 0 | 0 | | 2.5 | <1.0 |
| D. magna/acute/TUa | - | <1.0 | 8.5 | - | 0 | 0 | | 2.1 | <1.0 |
| FHM/acute/TUa | 5.7 (max of R1 and R3) | <1.0 | >16 | - | 0 | 0 | | 2.9 | <1.0 |
| C. dubia/chronic/TUc | - | <10 | 11.3 | - | 1.4 | 1.4 | | 4.7 | <10 |
| FHM/chronic/TUc | - | <10 | >16 | - | 5.7 | 2.8 | | 4.7 | <10 |
| | | | | | | | | | |
| Chemical characteristic - Parameter/mg/L | (footnote 2) | | | | | | | | |
| Total Dissolved Solids | 6456.0 | 1963.0 | 4100.0 | 1000.0 | - | - | | 1500.0 | 915.0 |
| Potassium | 2500.0 | 300.0 | 1700.0 | 90.0 | - | - | | 500.0 | 126.0 |
| Mercury (ng/L) | 4.0 | <1.3 | 1.5 | <0.05 | - | - | | - | <1.3 |
| | | | | | | | | | |

(1) - Maximum toxicity value from UF Runs 1 and 3 in which all 4 influent streams comprised an influent mix

(2) - Average concentrations from UF Runs 1 and 3 in which all 4 influent streams comprised an influent mix

(3) - Calculated projected effluent quality of outfall 002 (calculated based on upgradient well quality and UF water quality values - permit application)

(4) - Results of a Captur Technology Run in which all 4 influent streams comprised an influent mix

(5) - Calculated projected effluent quality of outfall 001 (calculated from upgradient well and frac tank water quality values - permit application)

Capture Tech Toxicity Summary

| Sample ID | GLC Number | Test Analysis | Percent Survival in 100% Effluent (for acute test only) | LC50 | TUa | NOEC | LOEC | TUc |
|---------------|------------|--|---|-------|-----|------------------------------------|----------------------------------|----------------------------------|
| Capture 3-4/1 | 8219 | 48-Hour C.dubia Acute | 85% | >100% | 0 | | | |
| Capture 3-4/1 | 8219 | 48-Hour D. magna Acute | 95% | >100% | 0 | | | |
| Capture 3-4/1 | 8219 | 96-Hour Fathead minnow Acute | 100% | >100% | 0 | | | |
| Capture 3-4/1 | 8219 | 7-Day C. dubia Chronic Survival and Reproduction | 100% | >100% | 0 | 100%-survival 50%-reprod. | >100%-survival 100%-reprod. | 0-survival 1.4-reprod. |
| Capture 3-4/1 | 8219 | 7-Day Fathead minnow Chronic Survival and Growth | 62.5% | >100% | 0 | 12.5% for both survival and growth | 25% for both survival and growth | 5.7 for both survival and growth |
| Capture 4-5/1 | 8220 | 48-Hour C.dubia Acute | 95% | >100% | 0 | | | |
| Capture 4-5/1 | 8220 | 48-Hour D. magna Acute | 100% | >100% | 0 | | | |
| Capture 4-5/1 | 8220 | 96-Hour Fathead minnow Acute | 100% | >100% | 0 | | | |
| Capture 4-5/1 | 8220 | 7-Day C. dubia Chronic Survival and Reproduction | 90% | >100% | 0 | 100%-survival 50%-reprod. | >100%-survival 100%-reprod. | 0-survival 1.4-reprod. |
| Capture 4-5/1 | 8220 | 7-Day Fathead minnow Chronic Survival and Growth | 65% | >100% | 0 | 25%-survival 50%-growth | 50%-survival 100%-growth | 2.8-survival 1.4-growth |

| Sample ID | GLC Number | Test Analysis | Percent Survival in 100% Effluent (for acute test only) | LC50 | TUa | NOEC | LOEC | TUc |
|--------------------|------------|--|---|--------|-------|-------------------------------------|------------------------------------|------------------------------------|
| Capture Effluent 2 | EEC 9094 | 48-Hour C.dubia Acute | 0% | <6.25% | >16.0 | | | |
| Capture Effluent 2 | 8221 | 48-Hour D. magna Acute | 0% | 11.8% | 8.5 | | | |
| Capture Effluent 2 | EEC 9094 | 48-Hour Fathead minnow Acute | 0% | <6.25% | >16.0 | | | |
| Capture Effluent 2 | EEC 9094 | 7-Day C. dubia Chronic Survival and Reproduction | 0% | 8.84% | 11.3 | 6.25%-survival 6.25%-reprod. | 12.5%-survival 12.5%-reprod. | 11.3-survival 11.3-reprod. |
| Capture Effluent 2 | EEC 9094 | 7-Day Fathead minnow Chronic Survival and Growth | 0% | <6.25% | >16.0 | <6.25% for both survival and growth | 6.25% for both survival and growth | >16.0 for both survival and growth |

LC50: Acute Lethal Toxicant Concentration

TUa: Acute Toxic Unit

NOEC: No-Observed Effect Concentration

LOEC: Lowest Observed Effect Concentration

TUc: Chronic Toxic Unit

ECT UF Tox Summary

Preliminary Acute Toxicity Test Results for the ECT Water Samples Collected from Bay Harbor on November 5, 10, 17, and, 19, 2009

| Sample ID GLC Number Date Collected | Test Organism and Test Duration | Test Concentrations Percent (%) Mortality at Test Completion | | | | | | Test Results | |
|--|---------------------------------------|---|-------|-------|-----|-----|------|------------------|-----------------|
| | | Con | 6.25% | 12.5% | 25% | 50% | 100% | LC ₅₀ | TU _a |
| BH Pilot R1 GLC# 7940 November 05, 2009 | <i>C. dubia</i> -48Hour | 0 | 20 | 100 | 100 | 100 | 100 | 8.11 | 12.3 |
| | FHM-96-Hour | 0 | 0 | 0 | 50 | 100 | 100 | 25.0 | 4.0 |
| R3 UF 0-10x GLC# 7942 November 10, 2009 | <i>C. dubia</i> -48Hour | 0 | 25 | 95 | 100 | 100 | 100 | 8.01 | 12.5 |
| | FHM-96-Hour | 5 | 5 | 0 | 100 | 100 | 100 | 17.5 | 5.7 |
| R6 GLC# 7953 November 17, 2009 | <i>C. dubia</i> -48Hour | 0 | 0 | 0 | 65 | 100 | 100 | 22.5 | 4.4 |
| | FHM-96-Hour | 0 | 0 | 0 | 0 | 75 | 100 | 42.0 | 2.4 |
| R7 GLC# 7961 November 19, 2009 | <i>C. dubia</i> -48Hour | 0 | 0 | 55 | 100 | 100 | 100 | 12.1 | 8.3 |
| | FHM-96-Hour | 0 | 5 | 10 | 100 | 100 | 100 | 16.7 | 6.0 |